

PRELIMINARY DATA SUMMARY

January 1993

U.S. Army Engineer Waterways Experiment Station
Coastal Engineering Research Center
Field Research Facility
Duck, North Carolina

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CERC Field Research Facility
Duck, North Carolina

This report provides a summary of basic oceanographic, meteorological and bottom profile data for the month. The data were obtained as part of the Measurements and Analysis work units at the U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center's Field Research Facility (FRF) in Duck, North Carolina. The FRF staff collected and analyzed these data. These summaries are intended to make the data readily available to all FRF users, and comments on their content and usefulness are invited.

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PART I: INTRODUCTION

The U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center's (CERC) Field Research Facility (FRF) is located on the Outer Banks of North Carolina, near the village of Duck (Figure 1).

The FRF research program provides a means for obtaining high-quality field data, particularly during storms, in support of the U.S. Army Corps of Engineers' coastal engineering research missions. The research pier is a reinforced concrete structure supported on 0.9-m-diam steel piles spaced 12.2 m apart along the pier's length and 4.6 m apart across the width. The pier deck is 6.1 m wide and extends from behind the duneline to about the 6-m water depth contour at a height of 7.6 m above the National Geodetic Vertical Datum (NGVD) of the year 1929. In addition, a main building contains offices, an instrument repair shop, and a data acquisition room.

One of the responsibilities of the FRF research program is the collection, analysis and dissemination of data on local oceanographic and meteorological conditions. Bottom profiles along both sides of the pier and periodic bathymetric surveys are also performed.

This summary is intended to provide basic data as soon as possible after they are obtained. Questions and/or comments concerning the data may be directed to Mr. Clifford F. Baron at (919) 261-3511.

Part II presents the meteorological data; Parts III through VI present oceanographic data; Part VII presents nearshore profiles and bathymetry; and Part VIII, if included, documents special events that occurred at the FRF during the month.

Table 1 is a list of instruments used, their operational status during the month, and the data collection status. Figure 2 identifies the location of the instruments. The water depths at the wave gages and current meters vary and may be determined from information contained in Figure 7. Other installation information is contained in Table 1.

Times given in the report, unless otherwise specified, are referenced to eastern standard time (EST).

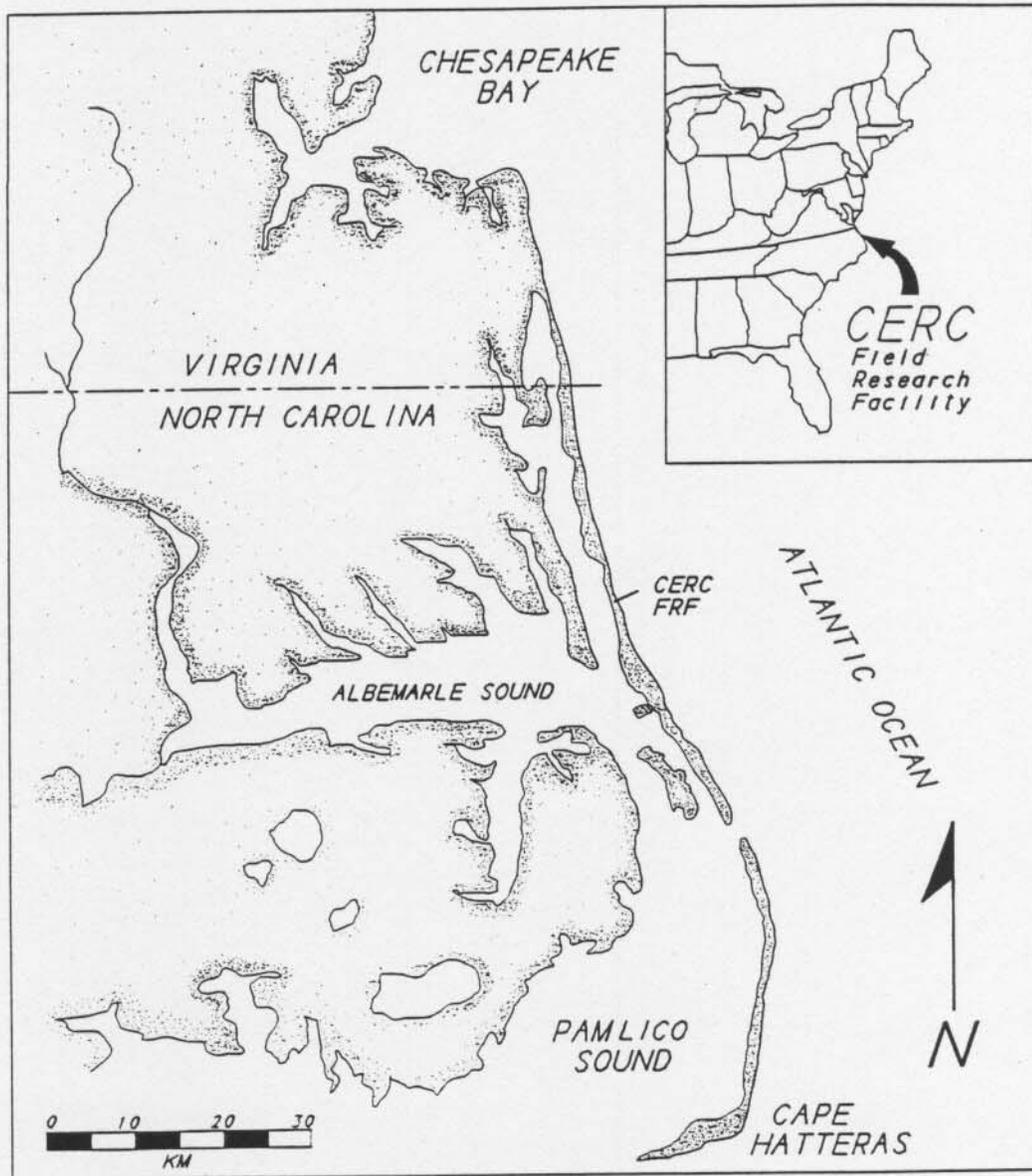


Figure 1. FRF Location Map

Table 1: Instrument Status/Data Availability

JANUARY 1993

Gage ID	Description/Remarks	Depth at Sensor		Day of the month																														
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
616	Barometric Pressure		Gage Status	*****																														
			Data Collected	***** / / *****																														
604	Precipitation		Gage Status	*****																														
			Data Collected	*****																														
624	Air Temperature		Gage Status	*****																														
			Data Collected	***** / / ***** - - -																														
932	Anemometer at seaward end of pier Elevation 19 m (NGVD)		Gage Status	*****																														
			Data Collected	***** / / *****																														
625	Baylor staff at station 18+60 on FRF pier	see Figure 7	Gage Status	*****																														
			Data Collected	***** / / *****																														
111	Pressure gage 309 m north of FRF pier (0.9 km offshore)	Approx. 7.8 m NGVD	Gage Status	*****																														
			Data Collected	***** / / *****																														
630	Waverider buoy 4.0 km offshore	Approx. 17 m NGVD	Gage Status	*****																														
			Data Collected	***** / / *****																														
519	Current meter 320 m north of FRF pier (0.9 km offshore)	see Figure 7	Gage Status	*****																														
			Data Collected	***** / / *****																														
865-1370	NOAA tide station at seaward end of FRF pier		Gage Status	*****																														
			Data Collected	***** / / ***** / *****																														
Supplemental Observations (daily oceanographic and meteorological observations)			Daily observation	*****																														

Gage Status
 Operational = *
 Partial = /
 Non-Operational = -

Daily Observation
 Complete = *
 Partial = /
 None = -

Data Collected
 All = *
 Partial = /
 None = -

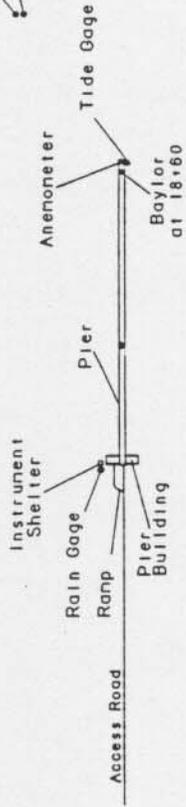


Pier Building at 0+40 to 1+00

12 Inch Rain Gage at 0+30

Instrument Shelter at 0+40

Current Meter
320 m north of pier
Pressure Gage
309 m north of pier



CURRITUCK SOUND

ATLANTIC OCEAN

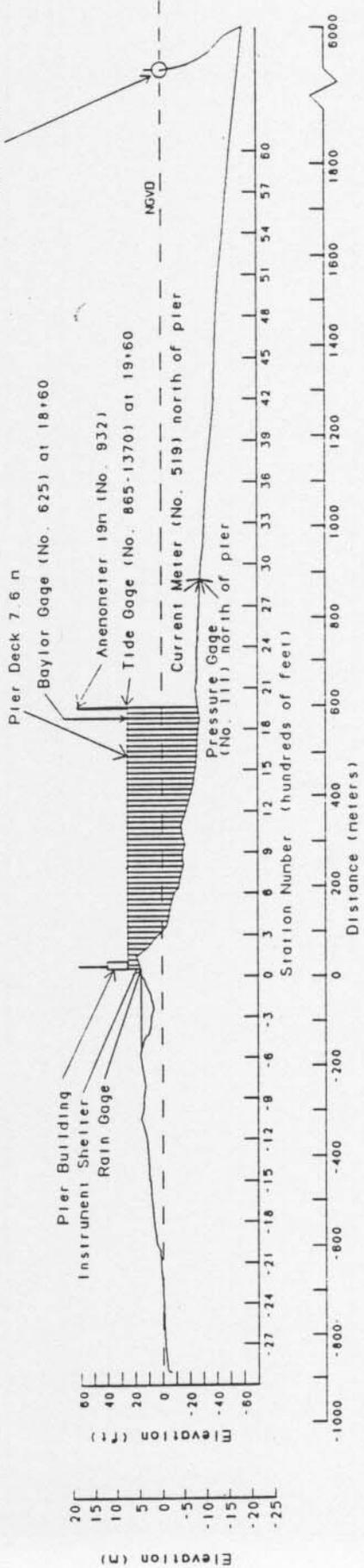


Figure 2. Instrument locations at FRF (all elevations from NGVD, all distances from FRF baseline).

PART II: METEOROLOGICAL DATA

A variety of instruments have been installed at the FRF (Figure 2) to monitor the meteorological conditions. The data presented in Table 2 are collected and stored using a Digital Equipment Corporation VAX 11/750. For each instrument identified in Table 1 as having analog outputs, chart records are obtained, a log is maintained and the records are stored for future reference.

Winds were measured at the end of the pier at an elevation of 19 m (Figure 2) using a WeatherMeasure Skyvane anemometer.

Monthly resultant wind speeds and directions are determined by vector averaging the data. Wind directions indicate where the wind is coming from. Temperature and atmospheric pressure means are the average of the values presented for the month. Total precipitation is the sum for the month.

The following may be useful for converting the data in Table 2 to other frequently used units of measurement:

1. Millimeters (mm) to inches (in.) -
 $\text{mm} \times .03937 = \text{in.}$
2. Millibars (mb) to inches of mercury (in. Hg) -
 $\text{mb} \times 0.02953 = \text{in. Hg}$
3. Degrees Celsius (C) to degrees Fahrenheit (F) -
 $(\text{C} \times 9/5) + 32 = \text{F}$
4. Meters per second (m/s) to knots (kn) -
 $\text{m/s} \times 1.943 = \text{kn}$

Table 2: Meteorological Data

Jan 1993

Day	Hour	Wind	Wind	Temperature	Atm	Precipitation
		Speed m/sec	Direction deg TN	deg C	Pressure mb	mm
1	100	6	241	13.7	1013.6	0
	700	3	307	12.3	1016.5	0
	1300	8	16	11.1	1020.9	0
	1900	10	7	8.9	1025.3	0
2	100	10	20	6.5	1027.6	0
	700	10	25	4.4	1030.4	0
	1300	7	26	5.0	1031.9	0
	1900	6	35	5.0	1033.1	0
3	100	5	38	6.4	1032.9	0
	700	5	67	8.8	1032.4	0
	1300	3	4	11.2	1031.7	0
	1900	2	169	11.2	1030.6	0
4	100	3	181	14.1	1029.1	0
	700	2	155	10.6	1028.2	0
	1300	5	185	19.7	1025.0	0
	1900	4	183	18.0	1022.2	0
5	100	8	178	19.1	1016.8	0
	700	6	183	19.3	1012.8	7
	1300	2	225	17.7	1013.0	10
	1900	4	2	13.5	1017.4	0
6	100	6	23	10.1	1019.8	0
	700	7	9	9.6	1020.2	0
	1300	7	6	9.6	1018.2	5
	1900	5	25	9.7	1018.9	0
7	100	6	17	10.2	1018.3	0
	700	6	26	9.7	1019.1	0
	1300	7	359	9.5	1017.5	0
	1900	3	344	10.8	1016.8	5
8	100	2	62	11.0	1012.8	5
	700	5	71	11.9	1009.5	29
	1300	8	1	10.5	1008.8	33
	1900	9	20	10.5	1011.9	0
9	100	9	24	11.0	1012.8	7
	700	10	33	11.0	1013.5	10
	1300	12	20	10.6	1013.5	17
	1900	13	27	10.4	1017.1	3
10	100	12	30	9.9	1020.2	0
	700	11	39	9.9	1022.7	0
	1300	9	6	9.9	1024.6	0
	1900	11	20	9.7	1025.7	0
11	100	9	2	9.8	1025.7	0
	700	8	352	8.7	1027.1	0
	1300	7	7	9.4	1025.6	0
	1900	6	19	10.1	1024.8	0
12	100	3	25	11.0	1021.4	3
	700	5	351	10.0	1020.2	0
	1300	4	344	10.3	1018.2	0
	1900	5	13	10.1	1017.5	0
13	100	0		10.4	1016.2	0
	700	2	202	11.8	1013.2	0
	1300	3	254	15.0	1008.7	0
	1900	4	263	14.5	1009.1	0
14	100	2	307	10.8	1012.5	0
	700	9	14	8.7	1017.7	0
	1300	6	5	9.5	1018.9	0
	1900					0
15	100		Hardware Error			0
	700					0
	1300					0
	1900	4	102	7.4	1017.7	0
16	100	5	73	7.6	1015.3	0
	700	10	57	7.7	1011.5	10
	1300	13	24	7.3	1006.8	3
	1900	12	1	6.2	1007.8	15

* electronic problems

(Continued)

(Sheet 1 of 2)

Table 2: Meteorological Data

Jan 1993

Day	Hour	Wind	Wind	Temperature	Atm	Precipitation
		Speed	Direction	deg C	Pressure	mm
		m/sec	deg TN		mb	
17	100	6	328	4.5	1008.4	3
	700	5	279	4.1	1011.4	0
	1300	6	247	6.9	1010.9	0
	1900	3	210	7.8	1013.3	0
18	100	4	251	7.6	1015.2	0
	700	8	19	6.7	1021.1	0
	1300	8	31	5.9	1024.0	0
	1900	6	40	5.2	1026.7	0
19	100	6	43	5.0	1027.8	0
	700	9	38	5.2	1029.5	0
	1300	10	18	4.4	1032.3	0
	1900	8	38	4.5	1034.8	0
20	100	7	54	5.9	1034.1	0
	700	6	35	5.7	1034.1	0
	1300	5	37	5.5	1032.9	0
	1900	3	39	3.9	1032.0	0
21	100	4	47	4.9	1030.6	0
	700	7	91	6.2	1029.9	0
	1300	3	98	8.2	1027.0	0
	1900	3	152	8.9	1024.1	0
22	100	6	183	14.0	1017.4	6
	700	1	232	12.3	1015.4	3
	1300	5	262	13.9	1012.6	0
	1900	1	204	11.4	1011.9	0
23	100	4	269	9.8	1015.3	0
	700	5	311	8.7	1019.7	0
	1300	2	66	11.7	1020.9	0
	1900	2	164	8.5	1021.7	0
24	100	3	190	9.3	1020.7	0
	700	3	182	9.3	1018.5	0
	1300	5	198	19.1	1013.3	0
	1900	9	233	18.0	1012.2	0
25	100	6	301	11.9	1016.3	3
	700	11	8	8.3	1022.2	0
	1300	7	18	5.3	1024.6	0
	1900	5	23	4.4	1026.2	0
26	100	11	32	5.2	1025.1	0
	700	11	39	4.3	1025.2	0
	1300	10	44	6.2	1021.6	0
	1900	11	32	7.1	1016.1	0
27	100	13	4	6.6	1009.9	0
	700	7	337	5.2	1009.5	0
	1300	9	353	6.8	1009.9	0
	1900	3	326	5.4	1013.4	0
28	100	3	305	3.3	1016.3	0
	700	3	297	2.0	1019.6	0
	1300	3	191	8.9	1019.1	0
	1900	5	209	8.1	1017.0	0
29	100	7	225	8.6	1015.9	0
	700	7	230	9.0	1014.6	0
	1300	6	250	11.4	1014.5	0
	1900	9	10	6.5	1021.9	0
30	100	9	3	3.0	1026.2	0
	700	3	254	1.3	1025.7	0
	1300	7	244	6.9	1022.8	0
	1900	6	235	7.8	1019.8	0
31	100	8	248	6.5	1017.0	0
	700	8	239	5.5	1012.4	0
	1300	8	237	13.1	1004.1	0
	1900	9	236	12.8	1000.6	0
		Resultant		Mean	Mean	Total
		3	11	9.1	1019.6	177

* electronic problems

(Sheet 2 of 2)

PART III: WAVE DATA

Wave data are collected from a Baylor staff gage (Gage 625), a pressure wave gage (Gage 111) and a Waverider buoy (Gage 630) as shown in Table 1 and Figure 2. The data are collected, analyzed, and stored on optical disc using a Digital Equipment Corporation VAX 11/750 programmed to sample the wave gages every 3 hr. The sampling rate is two times per second for five contiguous 34-min records. This report reflects the data collection periods of 0100, 0700, 1300, and 1900 EST. The results are based only on the first 34 minute record.

Wave height H_{m0} is an energy-based statistic equal to four times the standard deviation of the sea surface elevations. Wave height reported from the pressure gage has been compensated for hydrodynamic attenuation using linear wave theory. Wave period is identified from the computation of a variance (energy) spectrum with 60 deg of freedom calculated from a 34-min record. Peak wave period T_p is defined as the period associated with the maximum energy in the spectrum. When this analysis is complete, the data are written to optical disc.

Table 3 presents the wave heights and periods for each wave record obtained at 6 hr intervals during the month. The monthly means and standard deviations from the means shown in Table 3 are average values computed from this data. Figure 3 is a time history of all H_{m0} and T_p values obtained for all gages.

Differences in wave periods between wave gages (Table 3 and Figure 3) may be the result of wave breaking, wave reformation, the presence of multiple wave trains containing nearly equal energy, and statistical variations in spectral estimations.

Table 3: Wave Data

Jan 1993

Day	Hour	625 Baylor at 18+60		511 Pressure Gage		630 Offshr Wvrdr	
		Hmo,m	Tp,sec	Hmo,m	Tp,sec	Hmo,m	Tp,sec
1	0100	0.48	9.85	0.47	9.48	0.63	9.14
	0700	0.42	9.85	0.45	10.24	0.53	9.48
	1300	1.01	4.49	0.81	10.24	1.33	4.74
	1900	1.53	6.24	1.35	6.24	1.85	6.40
2	0100	1.36	5.69	1.26	5.95	1.59	5.95
	0700	1.54	7.11	1.36	6.24	1.80	5.69
	1300	1.34	6.40	1.22	6.92	1.52	6.40
	1900	1.06	6.09	0.90	9.85	1.15	5.69
3	0100	0.84	6.24	0.74	9.14	0.99	5.69
	0700	0.87	9.48	0.73	9.48	1.00	5.69
	1300	0.77	8.83	0.62	9.14	0.88	9.48
	1900	0.66	9.48	0.58	9.85	0.76	9.14
4	0100	0.60	9.14	0.63	9.14	0.76	8.83
	0700	0.60	10.24	0.59	9.85	0.74	9.48
	1300	0.68	8.83	0.62	9.14	0.91	8.83
	1900	0.68	8.83	0.64	8.83	0.95	5.95
5	0100	0.76	6.74	0.77	6.40	1.12	6.40
	0700	0.84	8.00	0.91	7.31	1.26	7.31
	1300	0.87	8.83	0.90	9.14	1.17	8.83
	1900	0.82	9.14	0.81	9.48	1.01	9.48
6	0100	0.86	9.14	0.78	9.14	1.09	8.83
	0700	1.04	4.92	0.83	9.14	1.23	9.14
	1300	1.14	8.53	0.89	8.53	1.40	8.83
	1900	0.87	8.53	0.75	8.53	1.09	8.83
7	0100	0.73	7.76	0.75	8.53	1.04	8.26
	0700	0.99	5.12	0.88	5.33	1.28	5.22
	1300	0.88	5.57	0.78	5.45	1.01	5.69
	1900	0.97	5.82	0.86	5.57	1.07	5.95
8	0100	0.80	7.76	0.74	8.53	0.91	8.26
	0700	0.83	8.53	0.69	8.83	1.01	7.53
	1300	0.98	7.76	0.89	7.53	1.15	7.11
	1900	1.29	5.95	1.10	6.09	1.65	5.95
9	0100	1.58	7.53	1.59	7.11	2.03	7.31
	0700	2.07	8.26	2.01	8.00	2.42	8.26
	1300	2.38	8.83	2.55	8.83	3.03	8.83
	1900	2.81	9.85	3.11	10.24	3.80	9.85
10	0100	2.66	10.67	2.98	9.85	3.74	10.24
	0700	2.92	11.64	3.20	11.64	3.89	11.64
	1300	2.54	12.19	2.72	12.19	3.12	11.64
	1900	2.49	11.64	2.67	11.13	2.99	12.19
11	0100	2.36	11.64	2.45	12.80	2.78	12.80
	0700	2.31	12.80	2.42	11.13	2.74	11.13
	1300	1.77	11.64	1.74	11.64	2.22	10.67
	1900	1.67	12.19	1.66	10.24	1.86	12.19
12	0100	1.46	9.85	1.40	9.85	1.75	10.24
	0700	1.38	9.85	1.41	10.67	1.70	9.85
	1300	1.26	10.24	1.19	9.85	1.42	10.24
	1900	1.14	7.53	1.27	11.13	1.42	9.14
13	0100	1.06	7.31	1.10	9.85	1.39	9.48
	0700	1.03	8.26	1.06	7.76	1.28	8.00
	1300	0.89	8.53	0.92	8.53	1.03	8.26
	1900	0.72	8.00	0.73	7.53	0.90	9.14
14	0100	0.67	10.24	0.63	9.85	0.90	10.24
	0700	1.08	4.20	0.89	4.41	1.25	4.74
	1300	1.01	5.82	0.93	5.82	1.27	5.82
	1900						
15	0100			Hardware Error			
	0700						
	1300						
	1900	1.43	14.22	1.61	14.22	1.74	13.47
16	0100	1.68	14.22	1.68	13.47	1.74	13.47
	0700	1.95	14.22	1.92	14.22	2.11	13.47
	1300	2.18	6.40	2.19	13.47	2.62	6.09
	1900	2.37	7.31	2.42	7.53	3.17	7.31

(Continued)

(Sheet 1 of 2)

Table 3: Wave Data

Jan 1993

Day	Hour	625		511		630	
		Baylor Hmo,m	at 18+60 Tp,sec	Pressure Hmo,m	Gage Tp,sec	Offshr Hmo,m	Wvrdr Tp,sec
17	0100	2.12	8.26	2.08	7.53	2.58	7.53
	0700	1.57	9.48	1.62	9.85	1.86	8.83
	1300	1.25	11.64	1.28	10.24	1.50	10.67
	1900	0.95	11.64	1.02	11.13	1.06	11.64
18	0100	0.73	11.13	0.77	11.13	0.81	10.67
	0700	0.68	9.85	0.53	10.24	0.80	9.85
	1300	1.22	5.45	1.13	12.19	1.48	5.45
	1900	1.03	6.24	0.98	11.13	1.56	11.64
19	0100	0.98	12.19	0.85	11.64	1.10	11.64
	0700	1.11	4.57	0.95	4.74	1.30	4.92
	1300	1.25	5.95	1.12	5.69	1.70	5.69
	1900	1.27	6.09	1.10	5.82	1.47	5.95
20	0100	1.07	6.74	0.94	6.40	1.28	6.24
	0700	0.88	8.53	0.80	8.83	1.00	6.24
	1300	0.85	8.53	0.71	8.26	0.89	8.83
	1900	0.68	8.53	0.58	7.53	0.85	8.26
21	0100	0.58	8.83	0.50	8.00	0.67	8.83
	0700	0.64	7.53	0.48	10.24	0.76	8.53
	1300	0.65	3.94	0.48	9.14	0.66	8.53
	1900	0.52	8.00	0.45	7.31	0.60	8.53
22	0100	0.82	5.45	0.62	5.82	1.08	5.57
	0700	0.83	7.31	0.81	7.76	1.23	7.76
	1300	0.71	8.53	0.69	8.53	0.89	8.26
	1900	0.74	8.53	0.76	9.14	1.00	8.53
23	0100	0.56	9.14	0.57	9.14	0.71	9.85
	0700	0.45	9.48	0.47	9.48	0.60	8.83
	1300	0.42	8.53	0.44	8.83	0.51	8.53
	1900	0.44	9.14	0.41	8.83	0.52	9.14
24	0100	0.41	8.83	0.39	9.14	0.47	9.48
	0700	0.36	12.80	0.40	11.64	0.45	12.19
	1300	0.41	11.64	0.39	12.19	0.55	11.64
	1900	0.51	6.24	0.55	7.11	0.80	6.56
25	0100	0.52	8.53	0.50	7.53	0.69	7.76
	0700	1.30	4.92	1.03	5.12	1.56	5.33
	1300	1.33	7.31	1.18	6.56	1.67	6.40
	1900	0.92	6.74	0.74	6.56	1.09	6.92
26	0100	1.19	4.66	0.93	4.74	1.35	4.66
	0700	1.69	6.09	1.51	5.95	2.04	5.82
	1300	1.59	6.74	1.36	6.24	1.94	6.40
	1900	1.91	6.74	1.71	6.74	2.31	7.11
27	0100	2.29	9.14	2.45	8.26	2.88	7.76
	0700	2.38	9.48	2.40	9.48	2.96	9.48
	1300	2.33	11.13	2.36	11.13	2.57	9.48
	1900	1.80	10.24	1.84	10.67	2.04	10.67
28	0100	1.39	11.64	1.48	11.64	1.52	9.85
	0700	1.35	11.13	1.31	11.13	1.47	10.67
	1300	1.13	11.64	1.13	11.13	1.35	11.13
	1900	1.01	10.24	0.95	11.13	1.21	11.64
29	0100	0.72	11.64	0.74	11.64	0.86	10.67
	0700	0.58	10.67	0.53	11.13	0.70	11.64
	1300	0.51	11.64	0.50	11.64	0.61	11.13
	1900	1.18	5.12	0.90	4.92	1.43	5.02
30	0100	1.45	6.40	1.38	6.74	1.90	6.40
	0700	1.02	6.92	0.92	7.31	1.26	6.40
	1300	0.47	10.24	0.44	10.24	0.67	10.24
	1900	0.35	9.85	0.35	9.85	0.43	9.85
31	0100	0.21	9.85	0.23	9.85	0.39	9.85
	0700	0.17	9.85	0.16	9.85	0.28	9.48
	1300	0.17	9.48	0.16	8.83	0.47	2.44
	1900	0.34	7.11	0.32	7.31	0.51	7.31
	Mean	1.13	8.62	1.09	8.95	1.39	8.48
	Std dev	0.62	2.30	0.67	2.17	0.77	2.24

(Sheet 2 of 2)

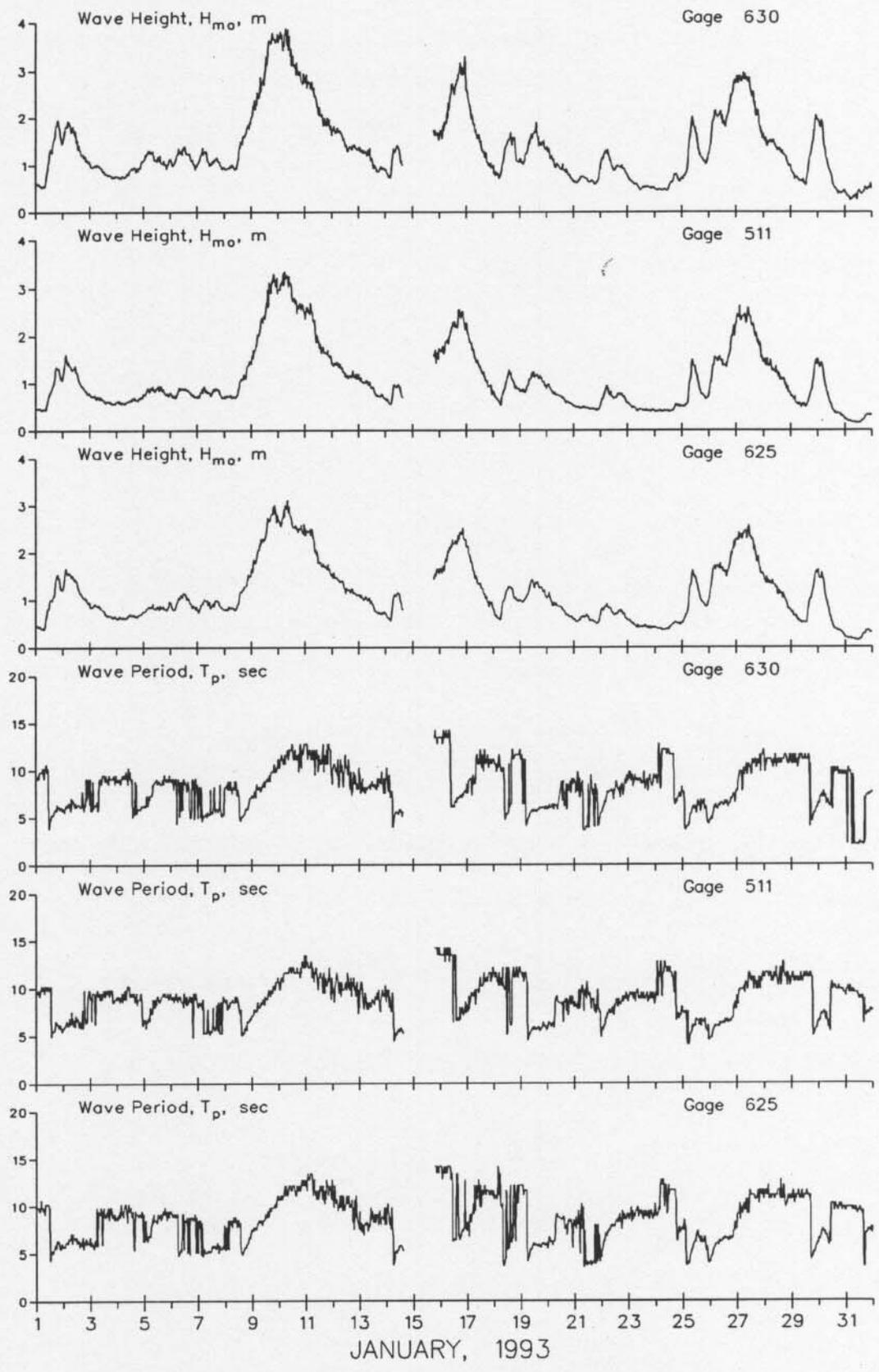


Figure 3. Time history of wave heights and periods

PART IV: CURRENT DATA

Current data (Table 4) are collected from a Marsh-McBirney electromagnetic biaxial current meter (Table 1 and Figure 2) and by visually observing the movement of dye on the water surface in the surf and at the seaward end of the pier, as well as 500 m updrift of the pier 12 m offshore.

Since the shoreline orientation is approximately N20W, longshore currents flow either toward 340 deg (i.e. northward) or toward 160 deg (i.e. southward). Similarly, cross-shore currents are either onshore (westward) or offshore (eastward).

All current speeds are given in centimeters per second (cm/sec). Resultant speeds and directions are determined by vector averaging the cross-shore and longshore data. Current directions indicate the direction that the current is moving towards.

IMPORTANT NOTE

Direction resultants regarding the current meter data (gages 519 and 529) may be in error by minus 5 degrees due to a faulty compass reading. Please call us if you must use this data.

Table 4: Current Data
Jan 1993

Day	Time	Alongshore Cross-shore Resultant	Pier Measurements					Beach Measurements (500m Updrift)			Current Meter 0.9 km Offshore Depth -5.6m (NGVD) ID #519		
			Dye at (579 m) (surface)		Dye at Mid-Surf Zone (surface) Distance from Baseline		Speed	Dir	Dye 12m offshore (surface)		Speed	Dir	
			Speed	Dir	(m)	Speed			Dir	Location			Speed
1	0100	-Along Cross Result										2 4 5	S off 100
1	0700	-Along Cross Result	44 22 49	S on 187	140	41 0 41	S 160	North	23	S		14 14 20	S off 114
1	1300	-Along Cross Result										29 15 32	S off 133
1	1900	-Along Cross Result										40 21 46	S off 132
2	0100	-Along Cross Result										37 19 41	S off 133
2	0700	-Along Cross Result	44 11 45	S on 174	177	87 22 90	S on 174	North	29	S		35 21 41	S off 129
2	1300	-Along Cross Result										29 16 33	S off 131
2	1900	-Along Cross Result										24 16 29	S off 126
3	0100	-Along Cross Result										13 8 16	S off 129
3	0700	-Along Cross Result	16 4 16	S on 174	152	44 4 44	N off 346	South	6	N		14 13 19	S off 118
3	1300	-Along Cross Result										5 9 10	S off 98
3	1900	-Along Cross Result										14 12 18	S off 119
4	0100	-Along Cross Result										15 4 15	S off 145
4	0700	-Along Cross Result	5 0 5	N off 340	165	27 7 27	N off 354	South	21	N		9 8 12	S off 120
4	1300	-Along Cross Result										9 5 10	N off 7
4	1900	-Along Cross Result										18 1 18	N 340
5	0100	-Along Cross Result										10 2 10	N on 330
5	0700	-Along Cross Result	51 8 51	N off 349	165	87 0 87	N 340	South	25	N		10 3 11	N on 325
5	1300	-Along Cross Result										22 5 23	N on 329
5	1900	-Along Cross Result										12 1 12	N off 345

KEY = All speeds in cm/sec
 N = Northward, Shore parallel
 S = Southward, Shore parallel
 on = onshore off = offshore

Table 4: Current Data (Continued)
Jan 1993

Day	Time	Alongshore Cross-shore Resultant	Pier Measurements				Beach Measurements (500m Updrift)			Current Meter 0.9 km Offshore Depth -5.6m (NGVD) ID #519		
			Dye at (579 m) (surface)		Dye at Mid-Surf Zone (surface)		Dye 12m offshore (surface)			Speed	Dir	
			Speed	Dir	Distance from Baseline (m)	Speed	Dir	Location	Speed			Dir
6	0100	-Along Cross Result								7 16 17	S off 96	
6	0700	-Along Cross Result	12 9 15	S on 197	165	28 21 35	N off 17	South	6	S	4 21 21	S off 82
6	1300	-Along Cross Result									8 12 15	S off 104
6	1900	-Along Cross Result									23 15 27	S off 128
7	0100	-Along Cross Result									43 21 48	S off 134
7	0700	-Along Cross Result	41 0 41	S 160	177	16 4 17	S on 174	North	56	S	29 18 35	S off 129
7	1300	-Along Cross Result									14 13 19	S off 118
7	1900	-Along Cross Result									38 17 41	S off 136
8	0100	-Along Cross Result									25 8 26	S off 142
8	0700	-Along Cross Result	61 0 61	S 160	140	11 8 14	N on 303	South	0		10 4 10	S off 140
8	1300	-Along Cross Result									31 21 37	S off 126
8	1900	-Along Cross Result									27 12 29	S off 136
9	0100	-Along Cross Result									31 10 32	S off 143
9	0700	-Along Cross Result	102 10 102	S on 166	140	76 23 80	S on 177	North	35	S	36 11 37	S off 143
9	1300	-Along Cross Result									57 26 62	S off 136
9	1900	-Along Cross Result									72 30 78	S off 137
10	0100	-Along Cross Result									76 39 85	S off 133
10	0700	-Along Cross Result	152 46 159	S on 177	140	68 7 68	S off 154	North	63	S	64 28 70	S off 136
10	1300	-Along Cross Result									75 31 81	S off 138
10	1900	-Along Cross Result									70 28 75	S off 138

KEY = All speeds in cm/sec
N = Northward, Shore parallel
S = Southward, Shore parallel
on = onshore off = offshore

Table 4: Current Data (Continued)
Jan 1993

Day	Time	Alongshore Cross-shore Resultant	Pier Measurements					Beach Measurements (500m Updrift)			Current Meter 0.9 km Offshore Depth -5.6m (NGVD) ID #519	
			Dye at (579 m) (surface)		Dye at Mid-Surf Zone (surface)		Dye 12m offshore (surface)			Speed	Dir	
			Speed	Dir	Distance from Baseline (m)	Speed	Dir	Location	Speed			Dir
11	0100	-Along Cross Result									57 22 61	S off 139
11	0700	-Along Cross Result	102 0 102	S 160	177	68 0 68	S 160		North	43 S	68 23 72	S off 141
11	1300	-Along Cross Result									45 21 49	S off 135
11	1900	-Along Cross Result									40 16 43	S off 139
12	0100	-Along Cross Result									41 21 46	S off 133
12	0700	-Along Cross Result	55 0 55	S 160	165	15 17 23	S off 110		North	39 S	34 13 36	S off 139
12	1300	-Along Cross Result									39 20 44	S off 133
12	1900	-Along Cross Result									38 21 43	S off 131
13	0100	-Along Cross Result									35 17 39	S off 134
13	0700	-Along Cross Result	14 0 14	S 160	177	12 28 31	S off 93		North	21 S	20 17 26	S off 121
13	1300	-Along Cross Result									23 15 28	S off 128
13	1900	-Along Cross Result									17 12 21	S off 124
14	0100	-Along Cross Result									17 10 20	S off 129
14	0700	-Along Cross Result	51 0 51	S 160	161	76 46 89	S off 129		North	47 S	42 18 46	S off 136
14	1300	-Along Cross Result									38 16 41	S off 137
14	1900	-Along Cross Result										
15	0100	-Along Cross Result										
15	0700	-Along Cross Result	41 0 41	S 160	166	25 8 27	S on 177		North	12 S		
15	1300	-Along Cross Result										
15	1900	-Along Cross Result									26 19 32	S off 124

KEY = All speeds in cm/sec
N = Northward, Shore parallel
S = Southward, Shore parallel
on = onshore off = offshore

Table 4: Current Data (Continued)
Jan 1993

Day	Time	Alongshore Cross-shore Resultant	Pier Measurements				Beach Measurements (500m Updrift)			Current Meter 0.9 km Offshore Depth -5.6m (NGVD) ID #519	
			Dye at (579 m) (surface)		Dye at Mid-Surf Zone (surface)		Dye 12m offshore (surface)			Speed	Dir
			Speed	Dir	Distance from Baseline (m)	Speed	Dir	Location	Speed		
16	0100	-Along Cross Result								13 7 14	S off 130
16	0700	-Along Cross Result	5 18 19	S on 236	189	20 8 22	S off 138	North	20 N	18 12 22	S off 126
16	1300	-Along Cross Result								32 20 38	S off 129
16	1900	-Along Cross Result								78 29 83	S off 140
17	0100	-Along Cross Result								31 8 32	S off 145
17	0700	-Along Cross Result	0 0 0		179	25 43 50	S off 100	North	7 N	20 14 24	S off 126
17	1300	-Along Cross Result								7 2 7	S off 141
17	1900	-Along Cross Result								15 6 16	S off 138
18	0100	-Along Cross Result								7 0 7	S off 160
18	0700	-Along Cross Result	36 9 37	S on 174	160	27 3 27	S off 154	North	46 S	3 9 9	S off 86
18	1300	-Along Cross Result								37 23 43	S off 128
18	1900	-Along Cross Result								37 16 40	S off 136
19	0100	-Along Cross Result								17 9 19	S off 132
19	0700	-Along Cross Result	47 5 47	S on 166	173	38 6 39	S off 151	North	31 S	29 16 33	S off 132
19	1300	-Along Cross Result								41 18 45	S off 137
19	1900	-Along Cross Result								44 19 48	S off 136
20	0100	-Along Cross Result								32 21 39	S off 127
20	0700	-Along Cross Result	30 11 32	S on 179	164	24 4 25	S on 169	North	10 S	25 14 29	S off 130
20	1300	-Along Cross Result								17 16 23	S off 117
20	1900	-Along Cross Result								20 16 25	S off 121

KEY = All speeds in cm/sec
N = Northward, Shore parallel
S = Southward, Shore parallel
on = onshore off = offshore

Table 4: Current Data (Continued)
Jan 1993

Day	Time	Alongshore Cross-shore Resultant ----- Time	Pier Measurements					Beach Measurements (500m Updrift)			Current Meter 0.9 km Offshore Depth -5.6m (NGVD) ID #519	
			Dye at (579 m) (surface)		Dye at Mid-Surf Zone (surface)		Location	Dye 12m offshore (surface)		Speed	Dir	
			Speed	Dir	Distance from Baseline (m)	Speed		Dir	Speed			Dir
21	0100	Along Cross Result								1 4 4	N off 52	
21	0700	Along Cross Result	0 0 0		164	9 4 10	N on 313	South	9 N	0 2 2	S on 250	
21	1300	Along Cross Result								5 4 7	S off 121	
21	1900	Along Cross Result								8 1 9	S off 151	
22	0100	Along Cross Result								15 5 16	S off 140	
22	0700	Along Cross Result	11 4 12	N on 318	167	10 4 11	N off 2	South	44 N	4 4 5	S off 112	
22	1300	Along Cross Result								4 5 6	S off 109	
22	1900	Along Cross Result								0 25 25	S off 70	
23	0100	Along Cross Result								3 5 6	S off 103	
23	0700	Along Cross Result	16 5 17	S off 141	140	15 4 15	S off 143	North	0	9 7 11	N off 18	
23	1300	Along Cross Result								5 14 15	S off 88	
23	1900	Along Cross Result								9 3 9	N off 358	
24	0100	Along Cross Result								6 3 7	N off 4	
24	0700	Along Cross Result	55 22 60	N off 2	140	25 11 28	N off 4	South	5 N	8 2 8	N on 329	
24	1300	Along Cross Result								7 3 7	N on 315	
24	1900	Along Cross Result								15 5 16	N on 323	
25	0100	Along Cross Result								2 2 3	N off 16	
25	0700	Along Cross Result	51 5 51	S off 154	167	68 20 71	S off 143	North	51 S	19 10 21	S off 133	
25	1300	Along Cross Result								32 16 36	S off 134	
25	1900	Along Cross Result								12 7 14	S off 129	

KEY = All speeds in cm/sec
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on = onshore off = offshore

Table 4: Current Data (Continued)
Jan 1993

Day	Time	Alongshore Cross-shore Resultant	Pier Measurements					Beach Measurements (500m Updrift)			Current Meter 0.9 km Offshore Depth -5.6m (NGVD) ID #519	
			Dye at (579 m) (surface) Speed	Dir	Dye at Mid-Surf Zone (surface) Distance from Baseline (m)	Speed	Dir	Dye 12m offshore (surface) Location	Speed	Dir	Speed	Dir
26	0100	Along Cross Result									22 12 25	S off 132
26	0700	Along Cross Result	36 11 37	S on 177	173	76 0 76	S 160	North	42	S	33 15 36	S off 136
26	1300	Along Cross Result									39 19 43	S off 135
26	1900	Along Cross Result									40 19 44	S off 135
27	0100	Along Cross Result									77 33 83	S off 137
27	0700	Along Cross Result	87 0 87	S 160	152	87 9 88	S on 166	North	46	S	81 28 86	S off 141
27	1300	Along Cross Result									52 15 54	S off 144
27	1900	Along Cross Result									44 13 46	S off 143
28	0100	Along Cross Result									20 15 25	S off 123
28	0700	Along Cross Result	36 0 36	S 160	166	30 5 31	S on 169	North	0		6 10 11	S off 100
28	1300	Along Cross Result									10 6 12	S off 131
28	1900	Along Cross Result									1 5 5	S on 240
29	0100	Along Cross Result									8 6 10	N on 302
29	0700	Along Cross Result	11 20 23	N off 40	140	16 7 18	N off 4	South	30	N	17 8 19	N on 316
29	1300	Along Cross Result									12 4 12	N on 322
29	1900	Along Cross Result									17 11 20	S off 129
30	0100	Along Cross Result									46 19 49	S off 138
30	0700	Along Cross Result	9 9 13	N off 25	152	47 47 66	S on 205	North	14	S	18 7 20	S off 138
30	1300	Along Cross Result									13 0 13	N 340
30	1900	Along Cross Result									16 5 17	N on 324

KEY = All speeds in cm/sec
N = Northward, Shore parallel
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on = onshore off = offshore

Table 4: Current Data (Concluded)
Jan 1993

Day	Time	Pier Measurements					Beach Measurements (500m Updrift)			Current Meter 0.9 km Offshore Depth -5.6m (NGVD) ID #519				
		Alongshore Cross-shore Resultant	Dye at (579 m) (surface)		Dye at Mid-Surf Zone (surface)		Dye 12m offshore (surface)			Speed	Dir			
			Speed	Dir	Distance from Baseline (m)	Speed	Dir	Location	Speed			Dir		
31	0100	-Along Cross Result								15	N	1	on	
										15		336		
31	0700	-Along Cross Result	34	N	152	10	N	South	5	N	13	N	1	on
			12	off		3	off				13		335	
			36	359		11	357				14	N		
31	1300	-Along Cross Result									14	N	1	on
											14		335	
31	1900	-Along Cross Result									7	N	3	on
											8		319	

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 N = Northward, Shore parallel
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PART V: SUPPLEMENTAL OBSERVATIONS

Visual wave direction measurements (Table 5) of both the primary wave train (i.e. that having the larger wave heights) and the secondary wave train (which must be clearly distinguishable as a wave train separate from the primary waves but not surface chop or capillary waves) are taken daily at the seaward end of the pier. The direction of the primary wave train just north of the seaward end of the pier is also determined using a Raytheon Marine Pathfinder radar and measuring the alignment of the wave crests at approximately the same location as the visual measurements. The pier axis (considered perpendicular to the beach at the FRF) is oriented 70 deg east of true north; consequently, wave angles greater than 70 deg indicate that the waves were coming from the south side of the pier.

The width of the surf zone (seawardmost breaker position to shoreline) is determined from the pier deck.

Measurements of surface water temperature, density, and visibility are also taken daily at the seaward end of the pier. A Bucket Thermometer is lowered about 0.3 m into the water and allowed to remain for at least one minute. The temperature is then read, and a hydrometer is used to determine the density. A Secchi disc is used to determine the depth of visibility.

Table 5: Supplemental Observations

Jan 1993

Day	Time	Wave Approach Angle at Pier End deg from True N		Radar Wave Angle deg from True N	Width of Surf Zone, m	Water Characteristics at Pier End		
		Primary	Secondary			Temp., C	Density g/cc	Secchi Vis., m
1	0920	20		100	59	8.9	1.0246	0.6
2	1000	35		50	197	7.8	1.0229	0.9
3	1000	55	10	50	143	7.4	1.0220	2.1
4	0730	80			121	7.8	1.0220	1.8
5	0840	110		105	157	8.9	1.0242	0.6
6	0840	30		40	136	8.6	1.0243	0.9
7	0840	50		90	110	7.8	1.0215	1.2
8	0850	80	15	65	37	8.3	1.0203	0.9
9	0830	60	30	60	273	8.3	1.0214	0.6
10	0845	70	50	75	580	7.8	1.0022	0.6
11	0850	55	15	65	463	7.5	1.0224	0.9
12	0836	60	15	70	162	7.5	1.0225	0.6
13	0855	55		inoperative	130	7.5	1.0212	0.9
14	1116	30	350	30	142	7.5	1.0205	1.2
15	1100	70			121	7.2	1.0198	1.5
16	0905	65		60	285	7.2	1.0198	0.9
17	0845	65			181	6.8	1.0222	0.6
18	0720	30	70	75	131	6.8	1.0228	0.9
19	0802	45		80	160	6.7	1.0229	0.9
20	0811	50		80	143	5.7	1.0195	1.5
21	0800	65		65	102	5.6	1.0180	1.5
22	0810	80	25		135	7.2	1.0226	0.9
23	0730	70	20	70	31	7.2	1.0236	0.9
24	0900	85			18	7.8	1.0238	1.2
25	0840	25	160	25	193	7.8	1.0255	0.6
26	0805	40		30	173	6.8	1.0256	0.6
27	0815	70		75	256	6.4	1.0200	0.6
28	0830	60			171	6.1	1.0200	0.9
29	0950	80			59	7.8	1.0247	0.6
30	0920	55		60	98	6.7	1.0250	0.6
31	0915	none visible			9	6.7	1.0247	0.9

PART VI: WATER LEVELS

Since 1978, the National Oceanic and Atmospheric Administration (NOAA)/National Ocean Service (NOS) has operated a primary tide station (No. 865-1370) at the seaward end of the FRF pier. A Leupold-Stevens digital recording float-type tide gage is used to collect instantaneous water level data every 6 minutes throughout the month.

The variation in water level during the month is shown in Figure 4 along with a list of mean and extreme values. This presentation is useful in identifying effects of both meteorological and astronomical forces on the open coast water level.

Table 6 contains the time at the center of each 12.42-hr tidal cycle and the range, high, low, and mean water levels during each tidal cycle.

Table 6: Water Levels,m NGVD

		Jan 1993			
Mid-Cycle	Low	High	Mean	Range	
Day	Time				
1	500	-0.21	0.48	0.14	0.69
1	1725	-0.34	0.55	0.07	0.90
2	550	-0.27	0.52	0.11	0.79
2	1815	-0.43	0.40	-0.04	0.83
3	640	-0.31	0.47	0.04	0.77
3	1906	-0.41	0.48	-0.04	0.89
4	731	-0.25	0.56	0.11	0.81
4	1956	-0.40	0.54	0.01	0.93
5	821	-0.47	0.63	0.02	1.10
5	2046	-0.49	0.68	0.01	1.17
6	912	-0.37	0.70	0.14	1.08
6	2137	-0.40	0.92	0.15	1.32
7	1002	-0.34	1.00	0.30	1.34
7	2227	-0.37	1.03	0.25	1.40
8	1052	-0.27	1.12	0.39	1.39
8	2318	-0.29	1.16	0.46	1.44
9					
10					
10					
11	58	-0.59	1.11	0.27	1.70
11	1324	-0.46	1.09	0.26	1.55
12	149	-0.44	0.92	0.23	1.36
12	1414	-0.45	0.93	0.19	1.38
13	239	-0.34	0.86	0.24	1.19
13	1504	-0.33	0.83	0.21	1.16
14	330	-0.23	0.88	0.30	1.10
14	1555	-0.27	0.72	0.23	0.98
15	420	-0.23	0.84	0.27	1.07
15	1645	-0.48	0.65	0.08	1.13
16	510	-0.52	0.83	0.26	1.35
16	1735	-0.45	0.69	0.28	1.14
17	601	-0.32	0.93	0.31	1.26
17	1826	-0.44	0.50	0.06	0.93
18	651	-0.24	0.68	0.21	0.92
18	1916	-0.38	0.44	0.05	0.82
19	741	-0.37	0.68	0.15	1.05
19	2007	-0.40	0.42	0.03	0.83
20	832	-0.49	0.69	0.08	1.19
20	2057	-0.50	0.41	-0.02	0.91
21	922	-0.48	0.69	0.09	1.17
21	2147	-0.29	0.58	0.15	0.87
22	1013	-0.37	0.80	0.23	1.17
22	2238	-0.35	0.63	0.15	0.98
23	1103	-0.44	0.69	0.12	1.13
23	2328	-0.51	0.49	0.01	1.00
24	1153	-0.48	0.65	0.07	1.12
25	19	-0.48	0.58	0.04	1.05
25	1244	-0.41	0.71	0.11	1.12
26	109	-0.32	0.70	0.11	1.03
26	1334	-0.27	0.75	0.23	1.02
27	159	0.04	0.85	0.42	0.81
27	1425	-0.19	0.94	0.33	1.13
28	250	-0.16	0.77	0.29	0.93
28	1515	-0.32	0.62	0.11	0.94
29	340	-0.42	0.43	-0.03	0.85
29	1605	-0.40	0.44	-0.03	0.84
30	431	-0.32	0.45	0.01	0.78
30	1656	-0.63	0.15	-0.30	0.78
31	521	-0.62	0.02	-0.32	0.63
31	1746	-0.62	0.22	-0.31	0.84

FRF Tide Heights

Jan 1993

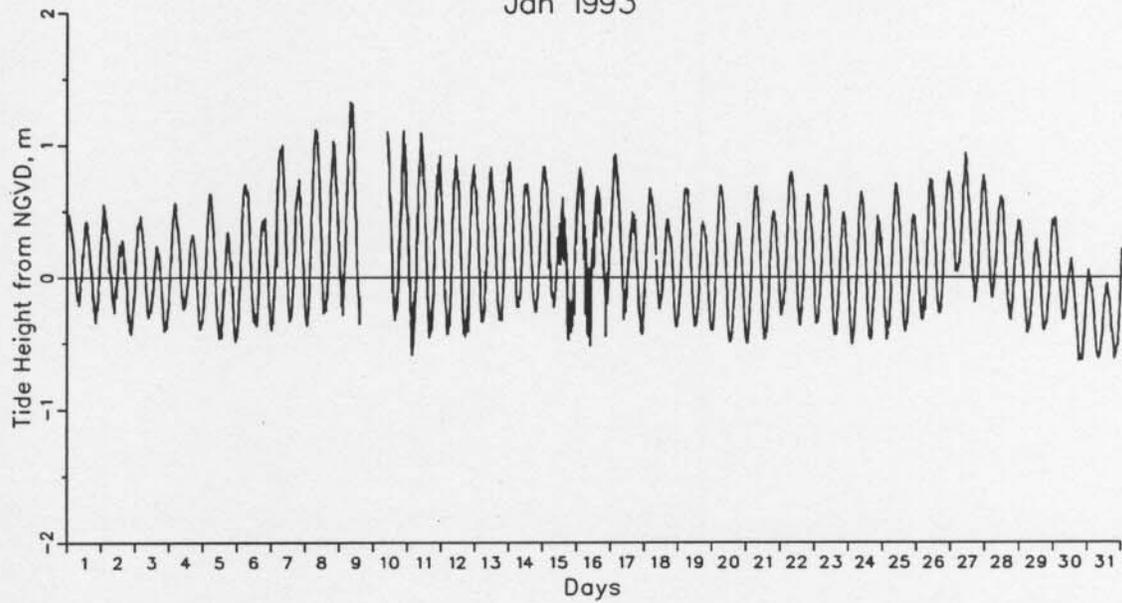


Figure 4. Water level time history

Monthly Water Levels, m NGVD

Extreme Low = -0.63 on day 30 at 1730 EST
Extreme High = 1.16 on day 9 at 642 EST
Monthly Mean = 0.13
Mean Low = -0.38
Mean High = 0.68
Mean Range = 1.05

PART VII: NEARSHORE PROFILES

A. Nearshore Profiles. In order to document profile response away from the pier, surveys of four profile lines extending 900 to 1,000 m from shore and located 489 and 581 m north and 517 and 608 m south of the FRF pier are conducted bi-weekly, after storms, and during more complete bathymetric surveys.

These profiles are obtained using the CRAB-Geodimeter surveying system; a Geodimeter 140-T self-tracking, electronic theodolite, distance meter, in combination with the Coastal Research Amphibious Buggy (CRAB), a 10.7 m high, self-powered, mobile tripod on wheels.

Figure 5 shows the last survey in December 1992 and the survey in January 1993 on profile line 188, located 517 m south of the pier.

The profile envelope (Figure 6) reflects the maximum changes that occurred on the profile during 1993. Cross-hatched areas indicate changes to the annual envelope which occurred in January.

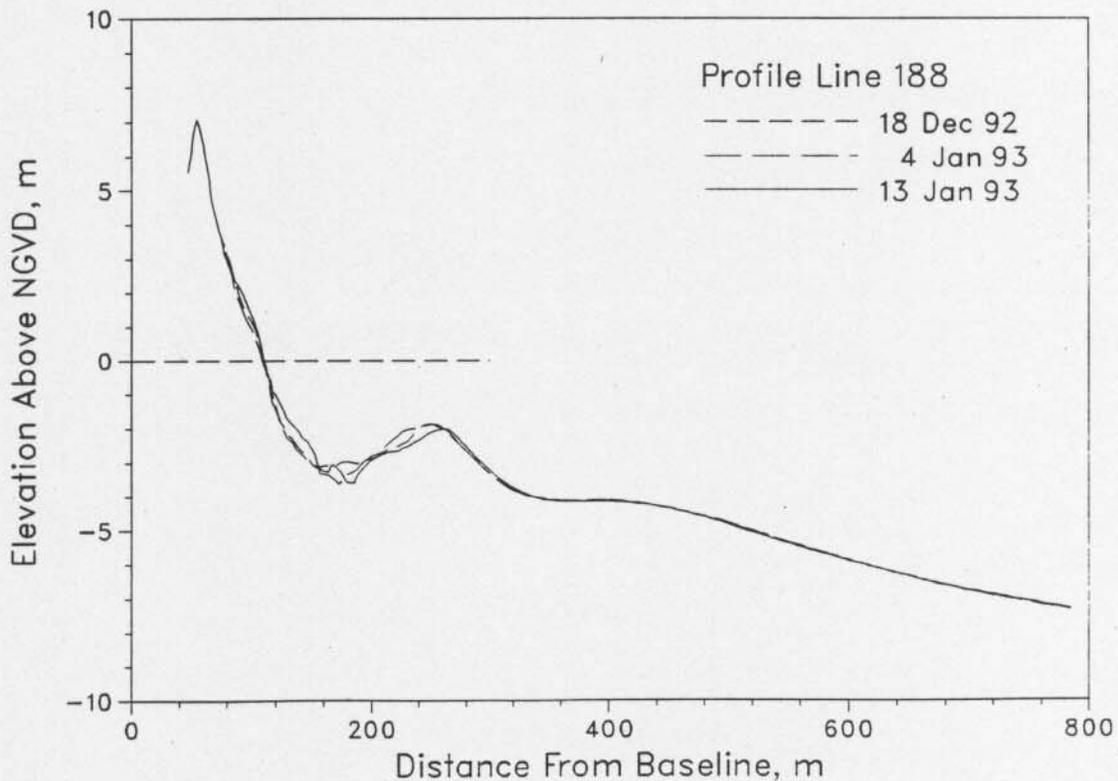


Figure 5. Monthly CRAB profiles on profile 188 - 517 m south of pier.

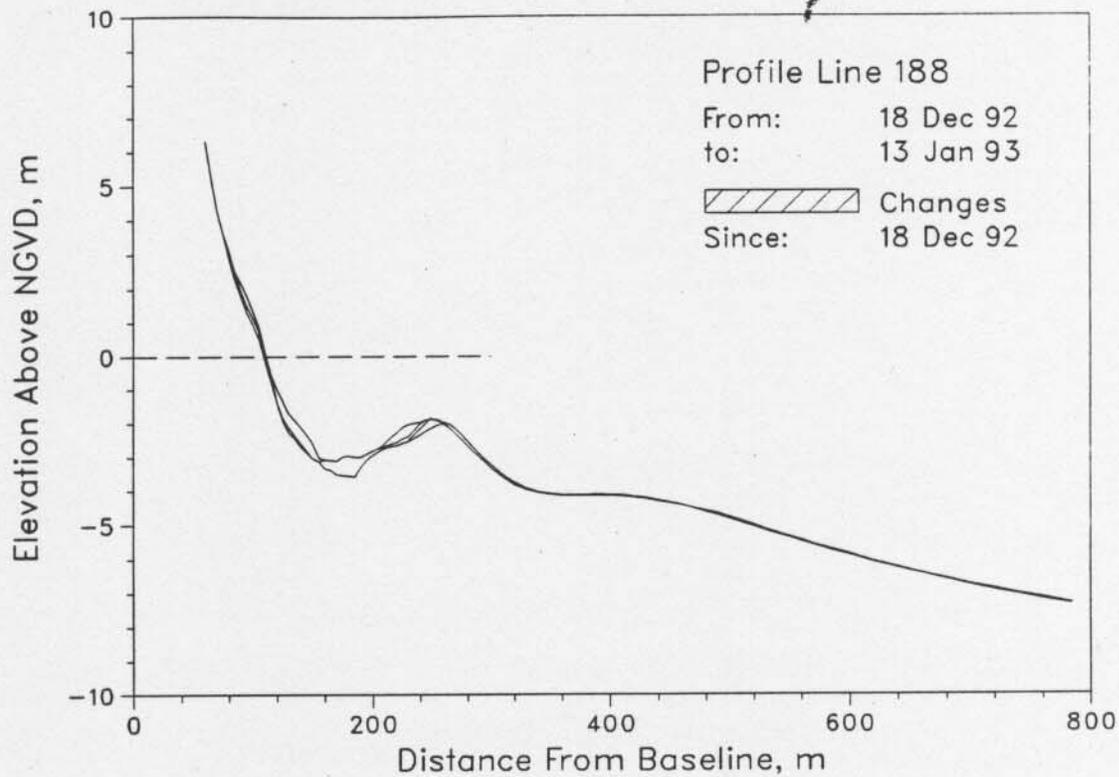


Figure 6. CRAB profile envelope - profile 188.

B. Bathymetry. Figure 7 includes a two- and three-dimensional contour map and a change plot derived from the bathymetric survey on 26 October. Wide contour lines on the change diagram represent eroded areas; thin lines indicate deposition.

Figure 7 is included for reference. The CRAB was being upgraded at this time. There was no complete survey during the month of January.

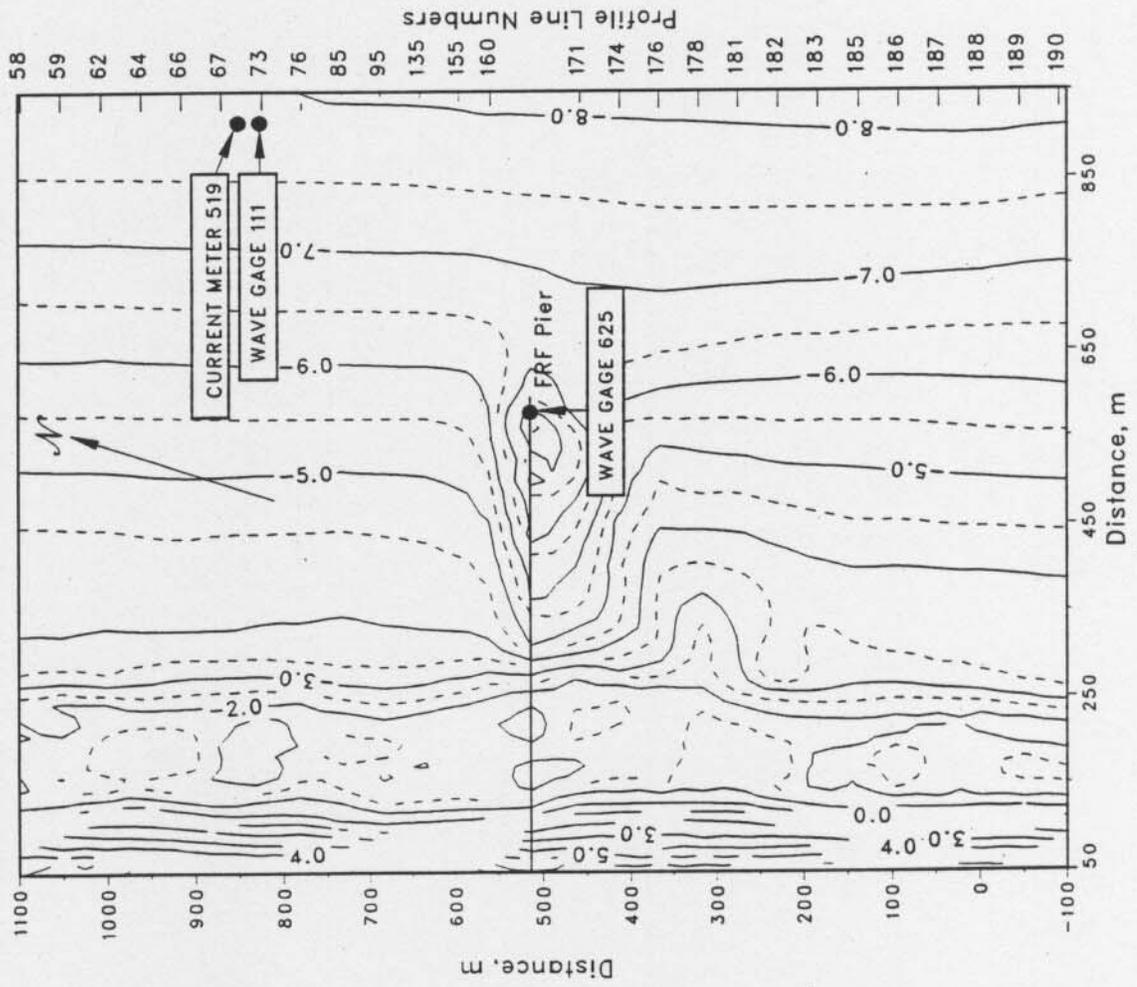
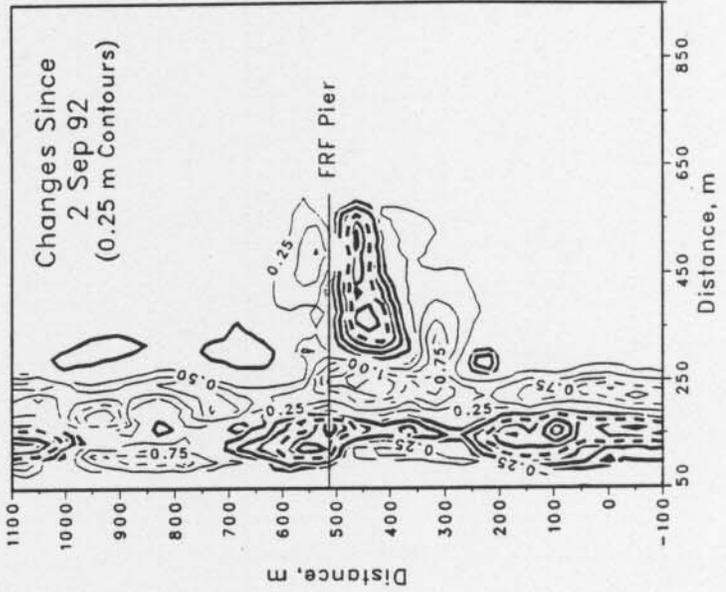
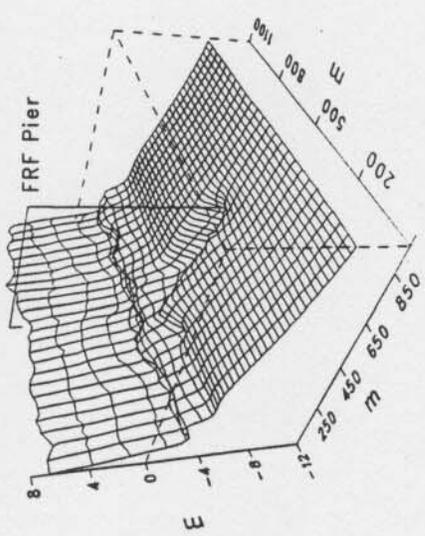


Figure 7. FRF bathymetry 26 Oct 92 depths relative to NGVD

PART VIII. SPECIAL EVENTS

A. Storm Data Collection. The following list identifies times when the wave height H_{mo} at the seaward end of the pier (i.e. as measured near the end of the pier) exceeded 2 m.

<u>Start</u>	<u>End</u>
9 January (0542)	11 January (1000)
16 January (0734)	17 January (0134)
26 January (1934)	27 January (1708)

B. Storm Synopsis.

9-11 January - Strong onshore winds were funnelled between a Canadian high pressure system over Alberta and a low pressure system about 120 km southeast of Cape Hatteras. Waves at gage 625 reached a maximum H_{mo} of 3.1 m ($T_p = 11.6$ s) at 0808 EST on 10 January. Maximum onshore winds reached 13 m/s from the northeast at 1900 EST on 9 January. Because the storm remained well offshore the atmospheric pressure remained steady at 1012 mb. There was 37 mm of precipitation.

16-17 January - A low pressure system that formed over the Gulf of Mexico, passed about 320 km southeast of Cape Hatteras producing maximum winds of 13 m/s at 1108 EST on 16 January. Waves at gage 625 reached a maximum H_{mo} of 2.52 m ($T_p = 7.53$ s) at 2042 EST on 16 January. Atmospheric pressure remained steady around 1006 mb. There was 31 mm of precipitation.

26-27 January - Developing over Florida on the morning of 26 January, this storm quickly moved to the Northeast remaining well offshore of Cape Hatteras. Waves at gage 625, reached a maximum H_{mo} of 2.58 m ($T_p = 11.64$ s) at 1108 EST on 27 January. Onshore winds reached 13.7 m/s at 2308 on 26 January. Atmospheric pressure remained steady around 1008 mb. There was no precipitation.

Distribution List

Government Agencies:

Back Bay National Wildlife Refuge	U.S. Geological Survey
USACE-OCE	U.S. Library of Congress
USACE-SAD	U.S. National Park Service
USACE-NAP	U.S. National Weather Service
USACE-SAW	U.S. Naval Academy
USACE-WES	U.S. Naval Civil Eng. Lab
NAVSAC	U.S. Naval Oceanographic Off.
NOAA/NOS/OMS	U.S. Naval Research Lab
National Marine Fisheries	

Colleges/Universities:

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California Inst. of Tech.	Stockton State College
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East Carolina University	University of Florida
Florida Inst. of Tech.	University of Maryland-College Park
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NC State University	University of N C-Seagrant Program
Old Dominion University	University of Virginia
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Queen's University, Ontario (Canada)
Ministry of Construction, Coastal Division (Japan)
Norwegian Hydrodynamic Laboratories (Norway)
University of Sydney (Australia)